

WE CLAIM:

1. A method for preparing nanoparticles comprising cerium oxide and zirconium, wherein the method comprises the steps of:
  - 5 (a) providing a first aqueous solution comprising zirconium oxychloride;
  - (b) mixing the first aqueous solution with a second aqueous solution comprising a first component selected from one of cerium nitrate and hexamethylenetetramine to form a first mixture;
  - 10 (c) mixing the first mixture with a third aqueous solution comprising a second component selected from cerium nitrate and hexamethylenetetramine to form a second mixture, wherein the second component is different from the first component;
  - (d) maintaining the second mixture at a temperature no higher than  
15 about 320 °K to form nanoparticles therein;
  - (e) separating the nanoparticles formed in step (d) from the second mixture; and
  - (f) sintering the nanoparticles separated in step (e) in air at a temperature ranging between about 500° C to about 1100°C.
- 20 2. The method of Claim 1, wherein the first aqueous solution has a concentration of zirconium oxychloride ranging from about 0.005 M to about 0.1 M.
3. The method of Claim 1, wherein the second aqueous solution comprises cerium nitrate in a concentration ranging from about 0.005 M to about 0.1 M.
4. The method of Claim 1, wherein the third aqueous solution comprises cerium  
25 nitrate in a concentration ranging from about 0.005 M to about 0.1 M.
5. The method of Claim 1, wherein the second aqueous solution comprises hexamethylenetetramine in a concentration ranging from about 0.01 M to about 1.5 M.
6. The method of Claim 1, wherein the third aqueous solution comprises  
30 hexamethylenetetramine in a concentration ranging from about 0.01 M to about 1.5 M.

7. The method of Claim 5, wherein the second aqueous solution comprises hexamethylenetetramine in a concentration of hexamethylenetetramine ranging from about 0.5 M to about 1.5 M.
8. The method of Claim 6, wherein the third aqueous solution comprises hexamethylenetetramine in a concentration of hexamethylenetetramine ranging from about 0.5 M to about 1.5 M.
9. The method of Claim 1, wherein step (d) comprises stirring the second mixture while it is being maintained at a temperature no higher than about 320°K to form nanoparticles therein.
10. The method of Claim 1, wherein the first and second mixtures are formed in a container having a mechanical stirrer, and the first mixture and the third aqueous solution are mixed with the mechanical stirrer to form the second mixture.
11. The method of Claim 1, wherein step (e) comprises maintaining the second mixture at a temperature no higher than about 320 °K for a time period between about 2 hours and about 24 hours.
12. The method of Claim 11, wherein the time period is between about 5 hours and about 24 hours.
13. The method of Claim 12, wherein the time period is between about 12 hours and about 24 hours.
14. The method of Claim 1, wherein step (e) comprises centrifuging the second mixture to separate the nanoparticles from the second mixture.
15. The method of Claim 1, wherein the second mixture is formed in a container, and the method comprises positioning the container inside a centrifuge and centrifuging the second mixture after formation of the nanoparticles therein for separating the nanoparticles from the second mixture.
16. The method of Claim 1, wherein the nanoparticles separated in step (e) are at least in part crystalline.
17. The method of Claim 1, wherein after step (f) is performed, the nanoparticles are at least in part crystalline.
18. The method of Claim 1, wherein the sintering of the nanoparticles in step (f) takes place at a temperature of about 550 °C.

19. The method of Claim 1, wherein the sintering of the nanoparticles in step (f) takes place at a temperature of about 900 °C.
20. The method of Claim 1, wherein the molar percentage of zirconium in the nanoparticles comprising cerium oxide and zirconium is in the range of about 20% to about 75%.
21. The method of Claim 1, wherein the first aqueous solution is provided in a container, and the second and third aqueous solutions are mixed with the first solution and the first mixture, respectively, by pumping the second and third aqueous solutions into the container through a plurality of inlets which are distributed throughout the container.
22. A method for preparing nanoparticles comprising cerium oxide and zirconium, wherein the method comprises the steps of:
- (a) providing a first aqueous solution comprising a first component selected from one of cerium nitrate and hexamethylenetetramine;
  - (b) mixing the first aqueous solution with a second aqueous solution comprising a second component selected from one of cerium nitrate and hexamethylenetetramine to form a first mixture, wherein the second component is different from the first component;
  - (c) maintaining the first mixture at a temperature no higher than about 320 °K for about 1 to about 5 hours;
  - (d) after step (c) mixing the first mixture with a third aqueous solution comprising zirconium oxychloride to form a second mixture;
  - (e) maintaining the second mixture at a temperature no higher than about 320 °K to form nanoparticles therein;
  - (f) separating the nanoparticles formed in step (e) from the second mixture; and
  - (g) sintering the nanoparticles separated in step (f) in air at a temperature in the range of about 500° C to about 1100°C.
23. A method for preparing nanoparticles comprising cerium oxide and zirconium, wherein the method comprises the steps of:

- (a) providing a first aqueous solution comprising zirconium oxychloride;
- (b) mixing the first aqueous solution with a second aqueous solution comprising hexamethylenetetramine to form a first mixture, wherein  
5 the first and second aqueous solution are mixed for an amount of time sufficient to allow formation of a precipitate in the first mixture;
- (c) mixing the first mixture with a third aqueous solution comprising a cerium nitrate to form a second mixture;
- (d) maintaining the second mixture at a temperature no higher than  
10 about 320 °K to form nanoparticles therein;
- (e) separating the nanoparticles formed in step (d) from the second mixture; and
- (f) sintering the nanoparticles separated in step (e) in air at a temperature ranging between about 500° C to about 1100°C.
- 15 24. The method of Claim 23, wherein the first and second aqueous solution are mixed in step (b) for between about 1 hour to about 2 hours.